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ABILITIES AND SKILLS AFFECTING ACHIEVEMENT IN SPELLING

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Of the subjects taught in the elementary school, spelling is perhaps the most frequently discussed by the public. In fact, academic proficiency is often judged by competency in this tool subject. Unfortunately, the level of achievement in spelling is often considered unsatisfactory. Because educators have been concerned about this lack of efficiency in spelling, many suggestions for its improvement have been offered to teachers. In addition, a noteworthy amount of research has been undertaken and a number of factors, or abilities and skills, that affect achievement in spelling have been identified. These factors appeared to form the following five groups:

1. Spelling achievement and intelligence
2. Spelling achievement and perceptual abilities
3. Spelling achievement and word analysis abilities
4. Spelling achievement and reading abilities
5. Spelling achievement and language abilities.

In this survey each of the above categories includes the specific abilities and skills found to determine success in spelling.

Spelling Achievement and Intelligence

Some educators observed that certain children were extremely poor in spelling and studied the relationship of general intelligence to success in spelling. In studies of disabled spellers in grades two through eight, Hollingworth (55), Gates (32, 34, 35), Garrison and Garrison (30), Houser (59), Schonell (90, 91), Terman(99), Russell (86, 87, 88) and Guiler (48) each found a close association between achievement in spelling and general intelligence. In studies of high school and college students, Crook (22), Williamson (108), Murray (74), and Kiefer and Sangren (65) found the relationships between intelligence and spelling achievement somewhat closer. Guiler and Lease (49) discovered that pupils of low intelligence lacked ability to spell, but Palmer's (78) studies revealed that although low intelligence indicated inferior spelling ability, high intelligence did not guarantee superior ability.

Other educators investigated the relationship between achievement in spelling and verbal and nonverbal intelligence separately. Verbal intelligence may be described as ability to deal with abstrac-

tions expressed in words. It involves a knowledge of word meanings including ability to classify words according to meaning and to discover analogies in written expression. Nonverbal intelligence may be described as ability to deal with pictorial, diagrammatic, and numerical materials. It does not emphasize the knowledge of word meanings or require reading ability.

Gates (32, 34) investigated the relationships between achievement in spelling and verbal intelligence at the elementary school level while Holmes (56) obtained information for college and high school students. In each investigation a closer association was found between achievement in spelling and verbal intelligence than between achievement in spelling and nonverbal intelligence. Evidence from the research seemed to indicate quite definitely that intelligence, and especially verbal intelligence, determined to a certain extent achievement in spelling.

Spelling Achievement and Perceptual Abilities

Other educators, in an effort to gain a greater understanding of the spelling process, studied various perceptual factors including mental imagery, visual discrimination and perception, visual memor, auditory discrimination and perception, and auditory memory.

Some of the early investigators believed that the method that a learner used to enable him to reproduce word forms included mental imagery. They also believed that the teacher should have an understanding of the manner in which imagery was used in studying spelling words. Spindler however, (95) was of the opinion that there were different types of imagery as auditory, visual, motor, and mixed, and that individuals used one or another of these types. Kline (67) found that individuals preferred one of these types of imagery, but Abbott (3) and M. R. Fernald (28) discovered that visual imagery was most commonly used. Holmes (56) found that auditory images of words contributed independently to spelling ability. Holmes, however, did not include the visual aspects of imagery in his study. On the other hand, Kiefer and Sangren (65) and Carey (15) found no relationship between spelling achievement and imagery of any type.

Despite these findings, certain literature on the teaching of spelling emphasizes a need for the use of imagery. Grace Fernald (27), Fitzgerald (29), and Betts (10) explain that there is a need for the learner to recall the visual image of words. However, Gates (34) concluded that poor visual imagery was an indication of inadequate visual discrimination and perception. Following the same reasoning, poor auditory imagery would be an indication of inadequate auditory discrimination and perception.

Many educators studied various visual abilities and skills to determine those that might affect achievement in spelling. Carmen (16) discovered that success in spelling depended upon a special ability to notice differences in words, or visual discrimination and perception ability. Others, Gates (34, 35), Sister Mary of the Visitation (103), and Sister Mary Benedict Phelan (81) reached similar conclusions. In a study of readiness for spelling among grade two children, Russell (87) found that visual perception was pertinent to success. Templin (96) noted that deaf and hard of hearing children made fewer spelling errors in written paragraphs and exhibited superior visual perception abilities to children with normal auditory acuity.

Some experimenters improved accuracy of visual discrimination and perception abilities and noted the effects on spelling achievement. By using word discrimination exercises, Mason (69) and Higley and Higley (53) increased the ability of elementary school children to spell. Gilbert (41), Hansburg (50), and Zyve (116) used various methods of improving accuracy of visual perception and noted significant gains in spelling achievement. In some studies the gains were especially noticeable among the poorer spellers of the groups in the experiment.

Visual memory, the ability to remember the forms of words, was studied among students of elementary school, and college. Howell (60), Kiefer and Sangren (65), and McGovney (71) found that the better spellers were superior to the poor ones in their ability to remember word-like forms. However, Weislogel (106) discovered that this relationship did not exist when visual memory was tested by use of designs and numbers instead of word-like forms.

Certain auditory abilities, such as auditory discrimination and perception, the ability to note differences and similarities in the sounds of words, were believed to affect success in spelling. Templin (98) found that some children were unable to discriminate between identical and unlike syllables in words. Bradford (13) discovered that some children were less able to distinguish between certain letter sounds than others, but the ability increased from grade to grade. In addition, Zedler (115) noted an improvement in the spelling performance of grade two children with special training in auditory discrimination. Others, Damgaard (23) and Holmes (56) observed that those who could discriminate musical elements more accurately, were the better spellers. Despite these findings, studies of deaf and hard of hearing children by Gates (37) and Templin (96) revealed that children who lacked auditory acuity were superior in spelling to those who possessed normal auditory acuity.

The importance of auditory memory, or the ability to remember

sounds in words, was investigated. In studies conducted by Whitehead (107), Winch (109, 110), Pressy (82), McGovney (71), Durrell (26), Baker (7), and Garrison and Garrison (30) the best spellers obtained the highest scores on tests of auditory memory. They concluded that auditory memory was a factor which determined, to a certain extent, success in spelling.

Some researchers compared the effects of visual and auditory abilities on achievement in spelling. In studies of spelling disability, Schonell (90, 91) discovered weaknesses in both visual and auditory perception and considered them among the important causes of the deficiency. In addition, Nichols (75), Russell (87), and Hudson and Toler (61) observed that both auditory and visual discrimination were closely related to achievement in spelling. However, Howell (60), Kiefer and Sangren (65), and Hartmann (52) noted that visual abilities were more important to achievement in spelling than auditory abilities. Although there is some lack of agreement as to which of these abilities is a greater determiner of success in spelling, no study indicates than any one of these perceptual abilities is insignificant. The research evidence clearly indicates that visual discrimination and perception, visual memory, auditory discrimination and perception, and auditory memory are contributors to achievement in spelling.

Spelling Achievement and Word Analysis Abilities

Many educators believed that word analysis abilities such as phonetic analysis, structural analysis, and a knowledge of word derivation contributed to efficiency in spelling. Others were of the opinion that a knowledge of spelling rules also determined proficiency in this tool subject.

Several investigators found that knowledge of phonetic analysis, or the ability to associate sounds with the appropriate letters, was necessary for spelling competency. In studies of disabled spellers, Hollingworth (55) observed that inability to handle letter sounds was one of the outstanding causes of disability. Davis (24), Spache (93), Watson (105), and Wolff (113) studied spelling errors made by elementary school children, and found that a large proportion of the mistakes indicated a lack of knowledge of phonetic analysis. Other educators, Garrison and Heard (31) Palmer (78), McGovney (71), and Russell (86) all observed that proficiency was accompanied by ability to handle letter sounds. Studies by Templin (97), Rudisill (85), Aaron (1), and Durrell (26) all showed that children in the elementary grades who were proficient in phonic knowledge were also competent in spelling. In addition, Russell (87) noted that a knowledge of phonetic analysis was of value to

readiness for spelling in grade two. When poor spellers in high school as well as in the elementary grades received instruction in phonetic analysis, Baker (7), Gates (34), Luser, Stanton and Doyle (68) and Witty (111) noted improvement in their spelling ability. The value of the phonetic analysis seemed to lie in the type of program provided. Gates (34) observed that it was necessary to place emphasis on the appearance and sounds of letters, syllables, and words rather than on minute phonetic elements such as *sh, ch, ns, ill, ea,* etc.

Some studies revealed the fact that a knowledge of structural analysis, or the ability to identify syllables, was associated with achievement in spelling. Wychoff (114) investigated the procedures used by good and poor spellers as they learned spelling words and found that the best ones noticed groups of letters in words. By photographs of eye movements made while spelling words were being studied, Abernethy (4) and Gilbert (40, 42) discovered that the good spellers analyzed words by syllables or related parts of words, while the poor spellers seemed to have no organized method of approach. In addition, Watson (105) and Witty (111) attributed many of the spelling errors made by high school students to a lack of attention to syllables in words. Furthermore, Gates (34) and Witty (111) found that when children received instruction in the use of syllables there was much improvement in their spelling ability. Despite these facts, when Greene (46)), T. D. Horne (58), and Wolfe and Breed (112) presented spelling words to children in syllabicated form, there was little or no increase in achievement in spelling. However, Osburn (76) recommended emphasis on syllables in teaching spelling.

A few educators found that a knowledge of word derivation, or an understanding of prefixes, suffixes, and roots of words was associated with success in spelling. By studying spelling errors, Horn and Ashbaugh (57) and Barthelmess (83) discovered that children in elementary grades found inflected forms of words much more difficult to spell than the base words from which they were derived. In an experimental study, Otterman (77) increased knowledge of prefixes and roots of words in a seventh grade class and obtained definite increase in spelling achievement, especially among the poorer spellers. However, in a study involving fifth grade children, Jackson (63) stressed root relationships, similar endings, and sound groupings with no significant improvement in spelling ability. It should be pointed out that the parts of words emphasized may have been different; there is no indication that the "similar endings" and the "sound groupings" were meaning units as were the "prefixes" and "roots of words" emphasized in Otterman's experiment.

The evidence from the research indicated that a knowledge of syllables, prefixes, and roots of words was associated with achievement in spelling.

Several attempts were made to discover the value of rules and generalizations to success in spelling. In a critical examination of spelling errors made by students in grade eight, twelve, and university, Masters (70) found there was a need for the application of certain rules and generalizations. W. A. Cook (21) tested university students on their spelling ability and their knowledge of spelling rules. Although the freshmen obtained the higher scores on the test of rules they were less competent than the seniors in spelling. When Turner (101 and Burton (14) gave instruction in spelling rules to students from grade eight through university they found no significant increase in spelling achievement. However, Carrol (18), Archer (5, 6), King (66), and Gates (38) discovered that children in the elementary grades used generalizations. The use of rules enabled children to increase their efficiency in spelling, but wrong use of some generalizations often caused spelling errors. Gates (33) discovered that elementary children who learned to use generalizations were better able to spell new words, especially derivatives, than those children who had not received instruction. Archer (6) concluded that, in addition to teaching the rule, the method in which it was taught was important. He stated that it should be taught inductively. Results of the research indicated that the use of certain rules and generalizations affected, to some degree, achievement in spelling.

Spelling Achievement and Reading Abilities

Many educators believed that achievement in spelling was closely associated with the various reading abilities. In a study of disabled readers, Monroe (73) found that low scores in achievement in both silent and oral reading were accompanied by low scores in spelling achievement. In other studies, Rudisill (85), Templin (97, Perry and Morrison (80), Betts (9), Gates (34), Russell (89), Hartmann (52), and Weislogel (106), discovered similar relationships between reading achievement and spelling achievement. Results of experimental studies by Gilbert (38, 39, 43) and Tyler (102) revealed that students in high school and college improved their spelling ability through reading.

The relationships between reading vocabulary, reading comprehension, word recognition, word meaning and spelling achievement were studied. Peake (79), Spache (94), Merrill (72), and C. W. Harris (51) noted that children in the elementary grades and junior high school who scored high on tests of reading vocabulary were also competent in spelling. Similar results were revealed by Sister

Phelan (81), Hughes (62), E. A. Bond (11), Russell (88, 89), Townsend (100), Gates (36), Waldman and Triggs (104), and Crook (22) for the relationships between the various reading abilities and achievement in spelling. The research evidence seemed to indicate that reading vocabulary, comprehension, word recognition, and word meaning were determiners of achievement in spelling.

Spelling Achievement and Language Abilities

Some educators believed that certain language abilities determined success in spelling. Some studied the relationship between the knowledge of word meanings, or the ability to define words and to identify meanings of words, and achievement in spelling. Others studied the relationship between general verbal ability, or ability to express ideas in writing, and spelling achievement, while some studied the relationship between accurate pronunciation and spelling ability.

In studies of the relationship between achievement in spelling and knowledge of word meanings, Hollingsworth (55), Cobb (20), Gates (32, 34), Houser (59), Russell (88, 89), Williamson (108), and Murray (74) all found a close association. Reed (83) showed that giving attention to meanings of words while they were being studied was a distinct advantage to success in spelling. Experimental studies by Delacato (25) and Richmond (84) indicated that improvement in general verbal abilities increased ability to spell. Each investigator concluded that a knowledge of word meanings was closely associated with spelling ability. It must be pointed out that this knowledge of word meanings included ability to recognize the written word; in no study was a measure of the listening vocabulary used.

Several educators were of the opinion that the accuracy with which words were pronounced also affected spelling ability. Studies of spelling errors by Book and Harter (12) Gregory (47) and Carrell and Pendergast (17) indicated that mispronunciation was one of the causes of poor spelling. In studies of disabled spellers, Schonell (92), Hollingworth (55), Kiefer and Sangren (65) and Murray (74) listed defective pronunciation as one cause of the disability. Russell (86) found that the commonest types of speech errors were the same as the spelling errors. In testimonials received from college students, Coard (19) and Hildebrandt (54) observed that mispronunciation was considered an outstanding cause of poor spelling ability. In an experiment, Kay (64) found that correcting the pronunciation of certain words produced a noticeable gain in ability to spell. There seemed to be sufficient evidence to indicate that a general knowledge of word meanings along with ability to

pronounce words clearly and accurately was closely associated with achievement in spelling.

Although several investigations have been conducted in some areas but few in others, there is sufficient evidence to indicate that many factors, or abilities and skills, are related to achievement in spelling. This list includes the following: general intelligence, verbal and nonverbal intelligence, visual discrimination and perception, visual memory, auditory discrimination and perception, auditory memory; a knowledge of phonetic analysis, structural analysis, and word derivation; ability to use rules and generalizations; reading abilities including vocabulary, comprehension, and word recognition; knowledge of word meanings, and use of accurate pronunciation. Because of the number of skills and abilities listed, it is possible that some are more significant to spelling achievement than others. Some information related to this will be provided in another article at a later date.

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LEISURE READING IN ALBERTA

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In the fall of 1958 The Library Sub-committee of the English Curriculum Committee arranged for a provincial survey to be made of the leisure reading programs in the junior and senior high schools. Questionnaires were distributed to 11,000 students and 2,000 teachers of leisure reading. The more significant findings and recommendations relating only to the junior high school grades (Grades 7, 8 and 9) are presented here.

The following leisure reading areas were investigated:

1. The library facilities and personnel at the service of school children. This included the types, sizes and scope of libraries and book collections, the supervision of libraries and the preparation of teachers for the presentation of the leisure reading program.
2. Current teaching procedures in leisure reading including the amount of school time provided, the emphasis, the checking and reporting methods and the motivational techniques.
3. The factors governing student choices of books as reported by both students and teachers.
4. The reading interests of students.
5. The quantity and quality of present leisure-time reading.
6. An evaluation of the present leisure reading program with special reference to the suggested book list *Reading for Pleasure.*
7. An evaluation of the present leisure reading course with reference to fundamental skills.
8. An evaluation of achievement in leisure reading in relation to the objectives set down by the Department of Education.
9. Suggested improvements to the present leisure reading program.

Results from both teacher and student questionnaires indicated that students were reading many books of good quality, with enjoyment.

Over 90% of the students said that reading was pleasurable. Teachers were more cautious, half of them estimating that 60% of their students enjoyed reading and one teacher in ten said that 90% of her students gained enjoyment from leisure reading.

Students were reading more than the suggested minimum of ten books per school year. The average number of books read by stu-

dents, according to their statements, was just over 16—15.7 for boys and 17.1 for girls—with 8.3 books for which credit was given and 8.1 books read without requesting credit. The peak year was Grade VIII with 17.9 books read. Rural school children read the most (18.3 books) and Roman Catholic Separate the least (13.8) books.

Teachers did not agree with the quantity claims of the students; 22% of the teachers said that half of their students were reading fewer than ten books per year; the mean was 6.3 books per student read for school credit.

Thirty-eight percent of the students stated that a lack of suitable books at school made it difficult to do sufficient reading. The leisure reading program could be improved, said 67% of all students, by more books of interest to them.

Students were given the opportunity of listing titles of books which they would recommend to friends. The majority of books listed were of satisfactory quality. Many books recognized as classics were listed. There were some titles of books of inferior quality and questionable subject matter listed, including *I'll Cry Tomorrow, Peyton Place,* and *Drop Them Colts,* but some of the most regularly listed were *Black Beauty, The Black Arrow, The Call of the Wild, Huckleberry Finn, Ivanhoe, Kidnapped, Treasure Island,* and *Tom Sawyer,* to mention a few. Forty-one percent of the students said that even if there were no leisure reading program they would still prefer books recognized as classics.

The fact that few unsuitable books were mentioned should be encouraging to teachers of leisure reading. Although it does not mean that children were not reading trash, it does indicate that students knew what sort of books were acceptable for listing on a school questionnaire; this is evidence that they had developed some taste in leisure reading.

There was some evidence to indicate that students were not reading widely. More than half of the teachers reported that about 50% of their students were obtaining variety in their reading experiences. Only 34 teachers of 800 reported excellent reading results as far as variety was concerned.

From the titles listed by students it was evident that students were not reading a sufficiently broad variety of books. It is suggested that our school book collections do not offer adequate variety. Children are reading *Nancy Drew* and *Sue Barton* and the *Hardy Boys* not just because they prefer these books but because our school library books lack heroines and heroes with which our students can identify themselves.

Teachers of leisure reading reported a shocking lack of suitable

books. For the majority of students the school was the principal source of reading material. Yet over one-half of the junior high schools had fewer than 200 books selected from Reading for Pleasure.

Teachers and students were aware of this lack; both listed it as the principal deterrent to reading. Students were reading interesting biography (their first choice of non-fiction) but listed no non-fiction in the categories "exploring new and strange lands", "accounts of war and conquest", and "occupations and careers", all of which rank high in their stated interests.

In fiction, "mystery and detective" was the favourite category among boys and girls at all grades and ages. Books are needed to bridge the gap from the *Hardy Boys to Sherlock Holmes.* Similar gaps were observed in "humour", "travel", and "stories of careers or personal achievement". Both variety and quantity are desperately needed in school book collections. Teachers said:

"It is impossible to carry on a very successful leisure reading program without books, books, books. If there are enough books of all kinds available, the competent teacher can get children to read even though the parents do not read."

"Books are in desperately short supply in this school. They are almost non-existent except those purchased by the students."

"More money is spent on bus transportation or athletics in one day than is spent for reading books in a year."

"Our schools lack central school libraries and librarians."

"Our classroom 'library' consists of only ten books."

"School authorities consider desks, blackboards and chalk as necessary equipment of a classroom, saws, planes and hammers as essential to Industrial Arts, but too often they overlook the need for books in developing a love for reading."

More than 90% of junior high school libraries were operated by classroom teachers or by student committees supervised by teachers. Twenty-eight teachers had had some library training; about one-half of the teachers of leisure reading had taken one or more English courses at University level.

Sixty percent of the teachers responsible for leisure reading had read, or were acquainted with, less than one-half of the books listed in *Reading for Pleasure.* This points to a real need in the Faculty of Education for a collection of *all* of the books recommended for reading by the Department of Education. It is suggested that such a collection be planned for in the library of the new Education Building. It has been suggested that this be named the "David Sullivan Collection" in memory of that eminent scholar-educator whose first love was literature.

Leisure reading was not being treated as a subject or as an important part of the English program: 153 classes of 800 were given less than 15 minutes per week for leisure reading and 308 classes were allotted less than one period each week.

Most teachers realized that efficient and pleasurable leisure reading demanded developmental and remedial teaching of the reading skills. Twelve percent of the students realized that lack of reading skill was acting as a deterrent to leisure reading. Nineteen percent of teachers claimed that more developmental and remedial reading would aid the leisure reading program. Forty-one percent of the teachers reporting indulged in an age-old prerogative of teachers; they declared that better developmental reading programs in the elementary schools would improve results in the junior high school leisure reading program. Fifty-five percent of the teachers were more realistic: they requested more help in diagnostic, remedial and developmental reading areas in order to assist them in improving their students' reading skills.

Teachers appeared to be uncomfortable about their qualifications for teaching leisure reading. About 50% of those reporting stated that teachers needed new and better teaching techniques in leisure reading. They felt that current teacher training programs were inadequate as far as preparation for the handling of leisure reading was concerned. They lacked knowledge of children's reading interests, of the books which they should be able to recommend to individual students and of the books which they recommended for purchase. They lacked knowledge of a range of motivation schemes with which to encourage reading.

The following were among the recommendations advanced:

Libraries

1. More books of interest to junior high school students should be provided for school libraries.
2. Leisure reading books should be obtained with due regard to variety, in order to fill gaps in both the fiction and non-fiction section of the school libraries.
3. More copies of certain books which are popular with students should be provided.
4. Central libraries should be established in every junior high school of over 100 students.
5. More use should be made of local libraries and travelling libraries.

6. A committee should be appointed by the Department of Education to study the junior high school libraries in Alberta. It is suggested that particular attention be given to the following items:
   (a) the advisability of appointing a provincial supervisor of school libraries;
   (b) the condition of the junior high school libraries with reference to physical facilities, bookstock, circulation, supervision and grants;
   (c) the need for full time or part time teacher-librarians in the large junior high schools.
7. An annual report should be made to the Department of Education, through the superintendents, on the library facilities of each junior high school.
8. School libraries should contain magazines such as *Sports Illustrated, Field and Stream, Hot Rod, Mechanics Illustrated, Newsweek, Time* and *Maclean's,* as well as *Boys' Life* and *Calling All Girls.*
9. A study should be made of student book clubs, such as the "Teenage Book Club", with special reference to the following:
   —the quality of the books offered for sale
   —their effects upon the reading habits and interests of the students
   —their value as steps on reading ladders.

Curriculum

1. Junior high school timetables should provide for one period of remedial or developmental reading and one period of leisure reading each week.
2. Plays and essays should be given more attention in the junior high school literature classes.

Teaching Procedures

1. A teacher's manual for leisure reading should be prepared by the Department of Education for the use of teachers of leisure reading. This might contain, among other items: teaching methods, motivation techniques, methods of checking and reporting leisure reading, gradings of books according to interest and difficulty levels, and criteria for book selection.
2. Reading is a highly individualized experience; the interests of the individual child should be respected and also widened, particularly in the direction of often neglected areas such as science, hobbies, careers, travel and humour.

3. Teachers should capitalize on current television and movie programs, particularly if these are based on significant literary works.
4. Teachers and librarians should have a much wider knowledge of books of interest to students.

Teacher Preparation

1. Additional courses in children's reading and library management should be provided by the Faculty of Education, University of Alberta.
2. Teachers-in-training should be given the opportunity of becoming acquainted with all of the books on the recommended leisure reading list—*Reading for Pleasure.*

PROLEGOMENA TO A SYSTEMATIC STUDY OF MOTIVATION IN EDUCATION: II MEDIATION VARIABLES AND HEBB

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When we talk of mediation variables intervening between stimulus and response, we are caught up in the Law of Effect. Thorndike (1911), in his early formulation of this Law, stated that stimulus-response connections are strengthened if followed by 'satisfaction,' weakened if followed by 'discomfort,' but the nature of the satisfier eluded him and he had to resort to tautological equivalents such as 'an O.K. reaction.' Hull (1943) solved this problem by regarding pleasure or 'satisfaction' as need-reduction, need being taken to be behavior directed at restoring the homeostatic balance of materials and commodities such as air, water, food, temperature, and the intactness of bodily tissue, which are necessary for the survival of the organism. For Hull, positive reinforcers which stimulate eating, drinking and so on, facilitate learning ('habit-strength') because they reduce the need. Later Hull's (1952) concept was altered verbally to 'drive-reduction' and 'drive-stimulus reductions' but the fundamental meaning remained the same: that a reduction of unpleasant stimuli associated with 'homeostatic' drives was the fundamental reinforcing condition of learning. Any learning which did not appear to be a product of this primary reinforcement, for example classroom learning, was attributed to 'learned' or 'secondary' reinforcement, in which a neutral stimulus associated with the primary reinforcer acquired reinforcing properties in its own right. However, this later concept has never been completely accepted by psychologists themselves—Harlow (1955), Razran (1955)—and its application to education has never seriously been considered. A new approach to the Law of Effect by means of a scrutiny of the more important mediation variables of a psychological sort is in order.

Two subcortical systems of the greatest significance for motivation have recently been discovered: the limbic system and the reticular activating system (RAS). Olds (1955) (1956) has pointed out that the classical exploration of the cortex and the discovery of the sensory and motor systems was carried out fairly early, but that other areas of the brain, the hypothalamus, the limbic system or rhinencephalon or 'smell brain,' remained unexplored, partly because they were difficult to get at without damaging the brain and partly because there was no available means of measuring correlat-

ed psychological functions. The first problem was overcome by the development of a very fine needle electrode which could be inserted into any point in the brain without damaging it, and the second by the invention of the Skinner box which measured the rewarding effect of a stimulus in terms of the frequency with which an animal would perform an act which led to that reward. Olds set up a self-stimulation circuit such that, when the rat pressed a treadle in the Skinner box, it triggered an electrical stimulus to the brain. If that stimulus were rewarding, that is, if it hit a 'pleasure center' in the brain, the rat would repeat the performance consistently; if the area were painful, the rat would immediately desist; if the effect were neutral, an intermediate amount of treadle-pressing would be observed (eg. in the classical sensory and motor systems). As Olds (1956) remarks: "By putting the animal in the 'do-it-yourself situation (i.e., pressing a lever to stimulate its own brain) we could translate the animal's strength of 'desire' into response frequency, which can be measured" (1956, p. 4).

Why is the electric current so rewarding? There are at least two answers. Firstly, Olds points out that the strongest reward or pleasure responses were obtained from the stimulation of areas of the hypothalmus and certain mid-brain nucleic regions which Hess and others found to be centres for the control of digestive, sexual, excretory and similar processes. Indeed, in the rhinencephalon (or limbic stystem), the effects were milder. Olds, accordingly, believes that the stimulation is rewarding because it excites the nerve cells which would be excited by satisfaction of the basic drives—hunger, sex, thirst, elimination and so forth. However, there must be a pleasure drive over and above the mere satisfaction of needs. There are two sources of evidence for this statement: firstly, fully-fed rats will indulge freely in self-stimulation in this way (1955, p. 91), and, secondly, rats will endure a painful shock in pursuit of electrical stimulation of this sort, a shock which hungry rats will not endure in pursuit of food. Therefore, stimulation of these areas yields pleasure additional to the satisfaction of needs. What is it?

Olds provides overwhelming evidence that the main pleasure zone, the septal region, has as its two chief functions those of motor inhibition (ibid. p. 101, p. 106, p. 107, pp. 109-110, p. 110, p. 14) and, to a lesser extent, motor facilitation (ibid., pp. 100-101). His theory of the conditions under which these opposite effects occur is similar to Berlyne's (1960) later and more sophisticated arousal theory. In effect, Old argues that the conditioned stimuli associated with rewards are "exciting" (this is Berlyne's 'orientation reactions' with arousal value) or facilitate motor response, while the rewards themselves have an inhibitory effect when they are actually stimulating

(Berlyne's arousal-reduction). From this we might hypothesise that pleasure is associated with the subject's awareness of negative feedback occurring, or of a cue that negative feedback is impending, manifested in the reduction of drives or drive stimuli—a very Hullian position. If this notion is correct, then we might expect experimental destruction of these areas to lead to agitated states and associated reactions of rage and restlessness (drive stimuli) and need-activity such as the hunger and search for food—which is what Magoun (1958, p. 60) reports.

So far so good. Pleasure is the absence of pain (or unpleasure) and must be present before learning can take place. Punishment, therefore, makes more pleasant, and better learned, behaviour which avoids it. But what homeostatic drive underlies learning? In particular, how can this system accommodate Harlow's (1954) demonstration of the existence of an exploratory drive and his contention that a great deal of learning goes on unrelated to homeostatic drives?

> Motivational theory and research have in the past put undue emphasis upon the role of the homeostatic drives—hunger, thirst, sex and elimination —as forces energising and directing human behavior. There are, indeed, some psychological theorists who would have us believe that all or most of our adult human motives are either directly dependent upon these homeostatic drives, or are second—or third-order derived drives conditioned upon visceral needs. The fact that derived drives based on homeostatic needs are unstable and transient: the fact the conditioned drive does not apparently reinstate the unlearned drive state, and the fact that human beings learn and live for days, weeks, or months without or in spite of a particular homeostatic need state does not disturb such psychological theorists in the least. (1954, p. 37).

Can this exploratory or intellectual drive be reduced to physiological dimensions? Recent research by Lindsley (1957), Magoun (1958), Malmo (1959), and Berlyne (1960) suggests that the connecting link is the reticular activating system (RAS), arousal of which is a necessary prerequisite of all behavior. The RAS is a non-specific alarm system located in the brain stem, one of its main functions being to arouse the brain. Any sensory message from the body feeds into this system which, when stimulated, sends arousal signals to the cortex. Sensory input from the body also reaches the cortex via specific sensory pathways through the thalamus. The aroused cortex can then interpret these signals which it is receiving by the more direct route. RAS is clearly essential for the activation and termination of physiological need-states. As the body is depleted of the required chemical substance, the RAS is activated and produces an intensified vigilance together with exploratory behavior. This is the necessary condition for finding an incentive or goal-object and engaging in consummatory behavior which leads to tension-reduction (Dell, 1958, p. 377). Arousal-

increase, therefore, initiates the physiological drive, arousal-reduction terminates it. The same is true of cognitive activity because Olds (1959) reports that arousal-increase aids the cortex in focussing attention in perceptual discrimination and in sustaining intellectual curiosity, and arousal-reduction supervenes with a decline in that curiosity. Physiological and cortical drives may be similarly classified, therefore, as different methods of promoting arousal-reduction in response to different cue functions.

But Lindsley has pointed out that cortical activity can also stimulate RAS . What can we say of this? An answer to this problem has been provided by Hebb.

Hebb (1955) points out that, just as sensory input reaches the cortex in two ways, directly via specific sensory pathways and indirectly via the RAS, so

> . . . in general terms, psychologically, we can now distinguish two quite different effects of a sensory event. One is the *cue function*, guiding behavior; the other, less obvious, is the arousal *vigilance function*. Without a foundation of arousal, the cue function cannot exist.
>
> And now I propose to you that, whatever you wish to call it, arousal in this sense is synonymous with a general drive state, and the conception of drive therefore assumes anatomical and physiological identity. Let me remind you of what we discussed earlier: the drive is an energizer, but not a guide: an engine but not a steering gear. These are precisely the specifications of activity in the arousal system. Also, learning is dependent on drive, according to drive theory, and this too is applicable in general terms—no arousal, no learning; and efficient learning is possible only in the waking, alert, responsive animal, in which the level of arousal is high. (1955, p. 249)

Hebb immediately notices that the arousal aspect of his theory can explain curiosity and problem-solving without recourse to the Hullian conception of reinforcement provided we make one assumption and state one fact. The assumption, based on the work of Bexton, Heron, and Scott (1954), is that man has a general drive to maintain an optimum level of arousal. Hebb and Thompson (1954) report that "animals will always act so as to produce an optimal level of excitation." (1954, p. 552). The fact is the impact of cortical activity on the arousal system, which means, psychologically, the " . . . *immediate drive value of cognitive processes, without intermediary.*" (1955, p. 252). The assumption and the fact, taken in combination, explain the positive attraction of risk taking, mild fear, problem-solving and mild frustration.

> When you stop to think of it, it is nothing short of extraordinary what trouble people will go to in order to get into more trouble at the bridge table, or on the golf course; and the fascination of the murder story, or thriller, and the newspaper accounts of real-life adventure or tragedy, is no less extraordinary. This state for excitement must not be forgotten when we are dealing with human motivation. It appears that, up to a certain point, threat and puzzle have positive motivating value, beyond that point negative value. (ibid., p. 250)

If we concentrate exclusively on the general drive state involved in all motivations, then it becomes possible to adopt a single-drive theory of motivation:

> The other single-mechanism theory of motivation which we may consider is that of the arousal system, the assumption that there is one drive state which differs only in the degree to which arousal occurs. This is the best unifying conception that is available to us at the present, but it too is probably unsatisfactory as it now stands.
>
> This theory implies that anger and fear, for example, have the same common core of undirected, and undirecting, emotional excitation (i.e. arousal), and that the differences which obviously exist between these two states lie in the cue functions, not in the kind of arousal. In anger, for example, the stimulus excites the arousal system, and also excites S-R connections and meditational processes that result in attacking behavior. In fear, the stimulus excites the same drive state, but different cue functions which determine flight. (1958, p. 1959).

However, if we concentrate on the sources of this arousal, this general drive state, then the theory becomes a multi-drive one because some motivated behavior depends exclusively on cortical functioning.

> The most plausible approach, perhaps, is to assume separate drives for the biologically primitive needs, each with its own pattern of activity in the brain-stem arousal system but still overlapping others, and to assume that other drive states originate in cortical processes and the 'down-flow' action of the cortex upon the brain-stem. (ibid. p. 160)

Hebb later reiterates this position and stresses the importance of this cognitive activity:

> We have already seen that the nonspecific projection system of the brain stem, whose activity constitutes arousal, is excited by downstream paths from the cortex as well as by afferent paths. If we assume that arousal constitutes a general drive state (with or without qualitative variations as discussed in the earlier part of this chapter), we might expect to find cases in which arousal, and therefore drive, depend not on the presence of primitive need but on the complex cue functions of the cortex. Such cases in fact appear to make up an important part of the higher animal's motivations. Though they are not at all well understood it is essential not to overlook them. (ibid., p. 170-171).

In a final summary headed 'The goals of the higher animal,' Hebb divides men's goals into two: firstly there are the primitive biological needs involved in survival which, if not satisfied, become dominant. However, when these needs are satisfied, a second set appear: cortically-induced needs.

> We find him looking for or inventing problems to solve, and mild risks to be run, apparently for their own sake. In man, with his high intellectual capacity, these tendencies produce complex and mechanical devils (eg. racing dinghies, bathyspheres, roulette wheels) and endless verbal elaborations of soluble and insoluble problems (eg., philosophy). The machinery of the nervous system, presumably enlarged under the influences of evolution as of value in seeking food and avoiding injury, has also developed certain intrinsic pecularities which become very evident in an economically successful human society—a kind of Frankenstein's monster whose activities are not all undesirable. (p. 175)

Writing from the point of view of an animal psychologist, Hebb classifies motivations of this cognitive sort into two types: approach (exploratory activity) and avoidance, which is roused by the perceptual conflict between previous familiarity and learning and present sensory input (ibid., p. 163). From the point of view of the educational psychologist, it would be better to say that perceptual and conceptual incongruity can stimulate arousal (1955, p. 252), although Hebb does not explain why this should be so.

Science is basically reductive, but what is the irreducible in psychological explanation? Hume once remarked that, beyond a certain stage of explanation you cannot go; you must stop asking questions. Is this true of Hebb's formulations? Is it quite reductive enough to say that we have " . . . a need to exercise the brain"? (ibid., p. 173). And is it economical to postulate cortically-induced intellectual drives which differ from the other drives in that they have no tension-reduction function? For an answer to these questions and for the most plausible attempt to categorize intellectual curiosity with other tension-reduction drives we must turn to Berlyne (1960).

But what, someone may interpose, has all this to do with the classroom situation?

In 1930 Hebb was a teacher in an elementary school in Verdun. He carried out an experiment designed to find out whether a change in teaching method would improve discipline in the best sense, " . . . pleasure and willingness on the part of the child in working, honour, good conduct, and courtesy" (1926, p. 1). The school was in an industrial setting with the socio-economic status of the parents low, the drive for achievement in school negligible, indiscipline and impudence rife and amount of retardation considerable in the six grades. At the root of it all, according to Hebb was a " . . . vicious circle of strap, dislike of school, bad work, more strap and so on" (ibid. p. 1). The general aim of the new teaching method is described:

> "In order, then, to get willing work from children who had never worked in school without force being applied, the staff took to heart the lesson of Tom Sawyer and his fence. To get that fence white-washed Tom discovered the easiest way would be to charge boys a price for the privilege of working at it. The moral, then, in school work, was to make work as pleasant as possible—and then speak of it always as a privilege, never to use it as a punishment, never to punish for not doing it.

Some of the detailed means are described in Hebb's later paper (1955):

> "All of the 600-odd pupils . . . ranging from six to fifteen years of age, were suddenly informed that they need do no work whatever unless they wanted to, that the punishment for being noisy and interrupting others' work was to be sent to the playground to play and that the reward for being good was to be allowed to do more work (1955, p. 246).

Hebb reports a significant improvement in discipline (by staff consensus), and in performance in all subjects previously detested—arithmetic drill, memory work, spelling and literature (by rough quantitative comparison). The effect in teachers can be imagined: freed from the strain of discipline, they found their professional tasks more pleasant.

Iu this early paper, Hebb makes no attempt to provide any psychological explanation of the pupils' changed attitude and motivation, but, in his later work (1955, p. 246), he explains the change in terms of his conceptual framework already described: bored with play, the children were motivated to work in order to raise the arousal level back to optimum—this is 'the immediate drive value of cognitive processes.'

This, then, is one of the educational implications of Hebb's work. Irrespective of whether we agree that the experimental findings do fit the theory, perhaps we might take the new method more to heart and put it into practice.

PART III: BERLYNE

Berlyne's basic hypothesis, validated by a considerable body of evidence, is that arousal-reduction is reinforcing (rewarding) and facilitates learning, the reduction being either of an immediate or of a delayed sort. Punishment of any type promotes arousal-increase, and any reward reinforcing learning logically implies the former, if we assume with Hebb and Berlyne an optimal level of arousal as a goal towards which the organism is striving. If we accept Berlyne's views it is psychologically unlikely that any learning can take place without the psycho-physiological basis of both punishment and reward being present. The cognitive drive of which Harlow made so much is simply one way of reducing arousal or, less frequently, of increasing it, and is therefore tied to the physiological tension-reduction model.

Berlyne then begins to establish his contention that arousal-increase underlies exploratory behaviour by showing that the variables formerly demonstrated as determinants of exploratory behaviour also activate arousal. He considers two main sorts of variables, affective (anxiety, especially under stress conditions, and emotional excitement), and collative variables (novelty, degree of change, suddenness of change, surprisingness, incongruity, complexity and uncertainty) and contends that these trigger off an arousal-increase associated with anxiety and an orientation reaction of vigilance which, in turn, sets off the exploratory behaviour for

arousal-reduction. Berlyne goes on to provide a neurophysiological basis for the effect these variables have on arousal.

> We know that the activation of the RAS sends facilitating impulses down to motor units and activating impulses up to the cortex. It seems that the activation of the cortex causes it to send inhibitory impulses back to the RAS to counteract the influence of whatever has been acting on the RAS and to restore the original level of arousal. A sudden, intense activation catches the cortex off its guard, as it were, and causes equilibrium to be momentarily upset. If, however, the activation of the RAS is gradual, the cortex has time to adjust its inhibitory feedback and prevent the process from getting out of hand. (1960, p. 181).

Two conceptions are logically implied in Berlyne's model: firstly, there is a quest for intermediate optimum levels of potential, and secondly, pleasurable arousal-increases ('arousal jags') are sought occasionally. The former states that there is a general optimum arousal level for the individual, and that the organism strives to maintain an optimal influx of arousal potential. The latter states that the individual seeks out stimuli with high arousal value on two conditions: firstly, that the arousal is increased to a moderate extent, and, secondly, that the arousal is promptly followed by relief. In other words, a moderate degree of uncertainty makes life less dull. Boredom occurs when there is a rise in arousal with no means of arousal-reduction. In the case of the experiments on sensory deprivation, the specific explanation of the origin of the rise is that inhibitory impulses from the cortex, which normally dampen arousal, are inactivated as a result of the monotonous stimulation, an event which releases RAS from restraint and allows the level of arousal to go up. In the case of monotonous stimuli being too strong to be soporific (e.g. a clock ticking), boredom results because this stimulation acts on RAS to keep arousal high and, at the same time, incapacitates the cortex from inhibiting RAS (ibid. p. 191).

Admittedly this latter view is in contrast to Hebb's position that boredom is due to a decline in the optimum level of cortical activity, and the restlessness and rise in arousal is an attempt on the part of the individual to get the arousal back to its optimum level. However, Hebb's position is not completely validated in the Bexton, Heron, and Scott experiments. Their subjects' restlessness was reported to be unpleasant, which is very odd if it raised the level of arousal to an optimum level. Certainly the authors report that their subjects were 'eager for stimulation,' but was this a result of the individual's 'need to exercise the brain'? Most of the subjects seemed to be incapable of engaging in cortical activity of a directive sort: statements were made such as, 'I could not control my mind,' 'I could not get rid of images,' and the subjects seemed to have little control of the content of their hallucination.

Certain interesting points arise from Berlyne's model, all of them with educational implications. The first is the notion that the reinforcement at the basis of all learning is arousal-reduction. Berlyne demonstrates that this applies to Woodworth's 'sequent learning,' occurring when S_1 is followed by S_2, and the subject learns to execute some response in preparation for S_2 during the interval between S_1 and S_2, which covers both Pavlovian and operant conditioning. Why is this sequence, S_1-R-S_2, learned? Berlyne hypothesises that S_1 induces perceptual curiosity and an 'indefinite expectancy of something more to follow' with its associated arousal, which is reduced by the presence of S_2. This arousal-reduction reinforces learning. Experimental extinction will set in immediately habituation to S_1 occurs. As evidence of this contention, Berlyne cites studies showing that the conditioned stimulus first evokes the physiological correlate of vigilance, cortical desynchronisation, which continues during the duration of that stimulus (ibid., p. 222), and Gastaut (in Jasper, 1958) reports that the obverse of Berlyne's position is true, that active inhibition of conditioning can be obtained by stimulating the reticular formation—in other words, arousal-increase inhibits conditioning. It should also be noted that, if Berlyne's position is true, relatively disinhibited people like extroverts will condition significantly less easily than introverts, a point established by Eysenck (1959).

All problems arising from concepts such as 'secondary reinforcement' of the transient type, in which the association between the conditioned and the unconditioned response is temporary and an artificial product of the researchers' experimental design, can be explained in this way. For example, Miles (1956) discovered that rats were more resistant to experimental extinction of lever- pressing in a Skinner box if there were present during that extinction period secondary reinforcers (a light and the click of the food-delivery mechanism) which had been associated during the original learning with the primary reinforcers (food-pellets). He also demonstrated that successive spontaneous recoveries were due to the secondary reinforcer alone. These findings can be explained using Berlyne in the following way. Arousal comes from two sources: firstly, from the need-deprivation and, secondly, from the perceptual curiosity. When the light-click comes together with the food, there is a reduction of arousal from both sources and hence learning. In the case of the group which receives secondary reinforcement, there is reduction of arousal due to the curiosity alone and hence the response of lever-pressing is continued for some time (light learning), but this time is short because the response does not reduce the arousal associated with the primary need of de-

privation. Spontaneous recovery might also be explained in the same way.

The advantages which accrue from this position, well established by Berlyne, that all reinforcement is primary and takes the form of arousal-reduction (occasionally of arousal-increase in the form of an arousal-jag) are considerable. In the first place, it gets round the necessity felt by Hull of bridging the gap between physiological 'social' drives (e.g. social approval) by hypothesising that the stimuli triggering off the latter were originally associated with unconditioned stimuli triggering off the former. 'Social approval' for Berlyne, by contrast, would simply be interpreted as a label given to behaviour which is designed to reduce arousal in ways specified by previous learning and training; for example, a person may be trained to experience high arousal if people disapprove of him. In this way, the doubtfully valid strategy of tying socially oriented drives to physiological behaviour is avoided.

In the same way, Berlyne's model also resolves three controversies which have exercised writers basing their learning theory on conditioning. It represents a possible alternative solution to that of Hull and Osgood of the retroaction paradox, a puzzle which taxes the non-cognitive theorist and which involves the basis of their consequences? Hull's solution was that the 'stimulus' trace' perseverates until it is contiguous with the reinforcing state of affairs. On the present view, what perseverates is an unusually high level of arousal associated with the stimulus, reduction of which takes place as a consequence of the reinforcement.

Berlyne's model also resolves the controversy between Hull and Guthrie on the conditions of learning. Guthrie believes that a response gets conditioned merely because stimulus and response are contiguous; reward (reinforcement) merely prevents the unlearning of what was learned through contiguous association. Hull, on the other hand, argues that the contiguous occurrence of stimulus and response leads to conditioning *only* when followed by reinforcement. In fact, each is correct after a fashion. Underlying conditioning is reinforcement (Hull is correct), but the reinforcement is arousal-reduction and not the drive-stimulus reduction advocated by Hull, and arousal-reduction can take place without the reduction of a primary drive (Guthrie is right). This position is consonant with that taken up by Estes (1960), who found wanting the concept of associative learning as a direct function of the amount of reinforcement, and replaced it by a " . . . picture of unitary associations the learning and unlearning of which proceed on an essentially all-or-none basis" (1960, p. 220). However, *that* learning, for Berlyne, would be based on the reinforcement of arousal-reduction.

A third controversy, that over latent learning, can be handled very satisfactorily by Berlyne. Latent learning, which occurs when an animal is allowed to explore a maze without reward and in a satiated state, is reinforced by a reduction in the arousal associated with the orientation reaction of perceptual curiosity.

Berlyne's motivational model can also be applied to the higher sorts of learning. If we assume with Freud that one of the more important functions of the mental apparatus is the control of stimuli, that the escape of arousal stimulates anxiety, and that a sustained orientation reaction is at the base of cognition, then cognitive activity is motivated by the need for arousal-reduction. One particularly good stimulus to the sort of cognitive activity termed 'epistemic curiosity' by Berlyne is conceptual conflict; the central purpose of this behaviour for Berlyne is always the reduction of arousal, although the behavior is also often reinforced by extrinsic rewards when knowledge is sought for practical ends (*ibid.* pp. 278-280). This 'cognitive dissonance' or conceptual incongruity raises the level of arousal because the cortex, having no forewarning of the impending arousal potential, cannot forestall a distrubance of arousal equilibrium. Any psychological conflict or blocking sustains arousal and will therefore prevent learning during its course, except that which results in arousal reduction, a fact which would account for the significantly negative relationship consistently observed between level of anxiety and level of complex cognitive performance (Sarason, 1960).

Berlyne's position has been foreshadowed to some extent by Mowrer's earlier work (republished in 1950), in which he demonstrated that preparatory set or expectancy can function as a secondary drive. Mowrer found that he could not explain classroom learning either by referring to the satisfaction of organic needs or by using unanalysed concepts such as 'need for social approval,' and, in an attempt to attribute all learning to reinforcement and the law of effect, he postulates an underlying state of 'tension or discomfort' involving anticipation of the recurrence of physiological needs, including the need to avoid a noxious stimulus. This state is coextensive with Berlyne's arousal and 'anticipation' is clearly Berlyne's orientation reaction. The similarity of the two systems can be further illustrated. Borrowing extensively from Freud's concept of 'signal anxiety,' Mowrer suggests that " . . . expectation and anxiety lie along a continuum with the former merging into the latter at the point at which it becomes uncomfortably intense, i.e. begins to take on motivational properties in its own right . . . " (1959, p. 18). In other words, anxiety is associated with significantly high arousal, or with the expectancy of that arousal . The deep

and intense expectation termed 'signal anxiety' motivates the individual to respond suitably to cues premonitory of the noxious stimulus (ibid., p. 20). Using Berlyne's theory, we might speculate that the learning of the association between cues and the painful stimulus would take place because of the great arousal jag associated with the pain and arousal-relief or lowering of expectancy (ibid. p. 63) coming immediately afterwards. Future occurrence of the cues activates anxious expectation and a variety of acts, one of which will be selected and fixated because it most effectively reduces the arousal associated with the anxiety. Perception of cues leads the individual to take realistic avoidance precautions (ibid., p. 21).

Mowrer's theory is a good deal more specific and overtly punitive than Berlyne's because he assumes that the discomfort associated with expectation will occur *only* when the individual anticipates deprivations in connection with organic needs, the main one for classroom purposes being the avoidance of noxious stimuli (ibid., p. 29), whereas Berlyne takes the position that the arousal and its associated attitude of expectations may have determinants other than threat, e.g. congnitve incongruity, a point which extends the range of its application to the classroom situation. However, both theorists accept the view that motivation involves a state which may be labelled as 'tension,' 'discomfort,' 'emotional arousal,' 'arousal,' and that learning is impossible without this primary state of arousal-imbalance, which mainly takes the form of a significant arousal-increase for Berlyne but which might hypothetically also take the form of a significant arousal-decrease below optimal level, with subsequent arousal-equilibrium. Punishment or conceptual incongruity and all motivating stimuli are simply ways of increasing this imbalance to make the subsequent need-reduction more effective as a reinforcing state of affairs.

The teacher, therefore, in order to ensure that the child learns has to arrange matters so that the cycle of arousal in the child follows a homeostatic pattern of arousal-increase followed by arousal-decrease to the optimum level. This can often be done by presenting arousal cues in the shape of a scowl, a movement or series of words which will arouse anxious expectation and a search for the correct and suitable behaviour and response. The cue for punishment should be switched off as soon as the correct behaviour is elicited so that this anxious expectation will be followed immediately by arousal relief. Mowrer points out that such motivating strategy cannot be applied to dull and neurotic children (ibid., p. 63). Another way to propel the child along the road of learning is to present conceptually difficult or incongruous problems, but the

efficiency of such a strategy depends on the aligning of the problem to the child's capacities.

Berlyne's model can integrate and thereby make more meaningful some persistent topics in educational psychology. 'Transfer of training' is a transfer of codes or invariants which are learned because they diminish the arousal associated with novelty and conceptual conflict. 'Level of aspiration' findings can be explained as a product of level of achievement interacting with level of arousal. Thus the normal or usual level of aspiration for the successful child is slightly above his level of past achievement, which is the academic correlate of the 'arousal jag'—the goal aspired to implies a certain amount of anxiety associated with a new effort, but, on the basis of past efforts, success is fairly well assured. The unrealistically high or unrealistically low levels of aspiration of the failure are methods directed at reducing arousal.

McClelland's (1955) (1958) achievement or achievement motivation can be explained quite simply as a product of child-rearing practices in which children are trained to believe that one of the main ways to reduce the arousal associated with parental disapproval is to do well in school. And what of the child who actually seeks out new problems to solve? Each previous cognitive success in the form of a solution of conceptual conflict is attended by primary reinforcement in the shape of arousal-reduction. The cumulative effect of pleasurable cognitive activity leads to the formation of a habit with compensatory properties. On the other hand, the unsuccessful child is understandably averse to becoming involved in an activity which raises, without reducing, arousal.

Aspects of Berlyne's model are congruent with and incorporate the concepts of other theorists. The concept of anxiety generated from his system fits that of Freud. For Berlyne, anxiety is a sudden escape of arousal from corticireticular control, and this resembles Freud's conception of the primary function of the central nervous system as the mastering of stimuli:

> '. . . the nervous system is an apparatus having the function of abolishing stimuli which reach it, or of reducing excitation to the lowest possible level . . . let us grant that the task of the central nervous system is . . . to *master stimuli* (1959, p. 63, originally 1915)

Harlow's (1958) approach to learning can be profitably elucidated by reading of Berlyne. According to Harlow,

> "Learning, all learning which has been adequately described and measured, appears to be the learned inhibition of responses and response tendencies which block the animal or fail to lead to some terminal response . . ." (1958, p. 285).

This can be explained by applying Berlyne's notion that not getting the right response will keep arousal high and impede learning;

getting the right response will facilitate arousal-reduction and hence learning. And what about the inhibition itself? This looks very like Berlyne's corticireticular control of arousal, a speculation which would link Berlyne and Thurstone (1924).

Any hedonistic position can be incorporated into Berlyne's theory, with the exception of Young's (1959) and Pfaffmann's (1960), which it cannot handle. For example, Troland's (1928) 'prospective hedonism' postulates that a man will be motivated to act if he considers that the outcome of his action will be more agreeable or less disagreeable than his present state. This becomes, in Berlyne's terms 'that a man will be motivated to act if he esticates that there is a high probability that certain cues will lead to an 'arousal jag' or 'arousal-reduction'. The rephrasing also fits exactly McClelland's (1951) (1955) general theory of the formation of motives, in which the assertion is made that organisms strive for pleasure and to avoid pain associated, respectively with small or large discrepancies from what he terms 'adaptation level,' which is Berlyne's intermediate arousal level, although McClelland conceives of a large number of different adaptation levels for different stimulus properties, whereas both Hebb and Berlyne conceive of only one optimum arousal level for a person to which many stimulus properties will contribute.

Theories of motivation based on arousal and cue functions (for example, the ethologists' IRMs and 'releasers,' 'Freudians' id and ego or primary and secondary processes) can be incorporated into Berlyne's system, as can the need-drive-incentive positions (Stone, 1951) and 'cognitive concepts' such as Festinger's (1958) 'cognitive dissonance', Abelson's (1959) 'cognitive imbalance' and Secord and Backman's (1961) 'striving to achieve congruency,' the latter being simply different versions of Berlyne's 'conceptual incongruity' which motivates the individual to reduce the arousal after some fashion or other. 'Values' as motivational stimuli are verbal habits which, as a result of their use in past training, motivate the individual to behave in ways that guarantee either arousal-reduction or an arousal-jag, and the power of advertising to motivate people to buy can be ascribed to its property of stimulating arousal and promising arousal-reduction when the product has been bought.

This, then, is the most plausible contemporary psychological synthesis with clear educational implications. Whatever motivates a student must provoke arousal-imbalance or the threat of arousal-imbalance and must provide arousal-relief or the promise of arousal-relief. These motivating stimuli sometimes take the form of the teacher's behaviour and attitude, and sometimes of perceptual and conceptual incongruity associated with the external environment,

and the cognitive activity, exploratory behaviour and learning which take place are designed to reduce that arousal.

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THE INFLUENCE OF HOMOGENEOUS GROUPING ON TEACHER MARKS IN THE HIGH SCHOOL

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Statement of the Problem

Among school administrators interest has been mounting with respect to grouping pupils on the basis of ability and achievement. The impact of this trend first affected the elementary schools where grouping has been used for reading and other instruction. This trend has not, as yet, made much impact upon administrative planning in many high schools. Grouping in high school is made on various bases, the most common of which are previous achievement and the program selected by the pupil. The subject of this paper is one of the controversial issues which has developed from the concern of teachers and heads of departments about the final grades received by pupils classified into homogeneous groups. Such classification, with all its administrative problems, must prove of value to the pupils and the school or the effort is not worthwhile. The validity of grades is one of the criteria of assessing the value of any school organization. Teacher influence is obvious on final results in high school courses where common examinations are not held. Those teachers who have not accepted the concept of classes composed of pupils with very similar ability, may still attempt to classify pupils within each class as superior, average and below-average, thereby losing the perspective of the entire program. Pupils falling in the below-average category in a superior class should possibly receive lower marks than if they had been in a heterogeneous class. Conversely, a pupil whose results place him in the upper level of a below-average homogeneous group could possibly receive higher marks than if he had been placed in a heterogeneous class. Teachers who make such errors in grading practices apparently equate the enriched program of the high ability classes with the meagre core curriculum of the low ability classes.

Job placement after graduation, or the necessity of reliable grading for those who transfer to other schools or enter institutions of higher learning, demands valid grading procedures. School marks which are affected by a pupil's level in a given group and possible teacher bias may adversely affect his future. The ramifications of grading procedures for the present and future welfare of all pupils suggest a need for an analytical comparison of the final results received by pupils grouped homogeneously or heterogeneously, to ascertain if a real problem of pupil evaluation exists.

This paper reports the findings of a study aiming to evaluate the effect of homogeneous grouping on teacher marks by comparing pupil grades in a school where students are grouped in homogeneous classes with those of pupils of equal ability in a school where pupils are grouped heterogeneously.

Experimental Design

This study attempts to compare the final Grade X results of students grouped homogeneously in classes according to their achievement on the Province of Alberta Grade IX Department of Education examinations with the Grade X results achieved by students who were not so grouped. However, problems of comparing the initial ability of the students entering the two high schools would have to be met before any attempt could be made at a comparison of the final ratings received in Grade X.

The experimental design chosen was such that performances of students of like ability were compared on a class-to-class basis. This meant that the pupils from School R, where they were not grouped homogeneously, would, for purposes of comparison only, be artificially grouped into classes on the basis of homogeneous achievement using the same common Grade IX examination results. These classes would then parallel those of School S where the students had been initially grouped on the basis of homogeneous grade IX test achievement. The purpose of this artificial grouping was to provide comparison groups of equivalent initial ability.

Sample

Two Edmonton public high schools were chosen for this study. School S classified its Grade X pupils homogeneously on the basis of achievement on the Province-wide Grade IX Department of Education examinations administered in June of the previous year. The other school, School R, assigned them randomly. In all, 248 Grade X students from School S and 197 Grade X students from School R were used in this study. All students met the following qualifications: (1) they were enrolled in the Grade X matriculation program in the 1957-58 school year; (2) they had written the Province-

wide Grade IX Department of Education examinations in June 1957; (3) during the previous year each had been enrolled in a junior high school operated by the Edmonton Public School Board.

Study Variables

The data were taken from the cumulative records of the students used in this study. Additional information came from the administrative records of the high school concerned.

Eight Grade IX variables were used in this study. These were the stanine records received by each pupil on the Grade IX Department of Education examinations in Reading, Social Studies, Language, Mathematics, Science and Literature, the aggregate stanine scores and the Total score on the School and College Ability Test, Level 3 (SCAT 3). The latter was reported as a percentile score.

The Grade X variables consisted of the marks received in the following Grade X subjects: the common core of Language 10, Literature 10, Social Studies 10, Mathematics 10, Science 10, Physical Education 10, Health and Personal Development 10 (H. & P.D. 10), and electives. It is noted that all students took the common core of subjects listed above. Because of the wide variety of electives available to these students, it was deemed advisable for purposes of this study to average the scores obtained in these electives into a single Grade X variable. This has been simply identified as Electives.

Criteria Used For Artificial Grouping Of Students From Heterogeneous Ability Classes Into Classes Parallel To Those Composed Of Homogeneous Ability Students

Pupils taking the matriculation program in School S had been grouped into nine Grade X classes on the basis of achievement on the Grade IX Department of Education examinations. Placement was based on the aggregate stanine score received by each pupil. In establishing artificial classes of students of homogeneous ability from School R, to match the classes in School S, the following steps were taken: (1) each class was kept approximately proportional in number to the corresponding class in School S based on the ratio of pupils in each school (197 from School R, 248 from School S); (2) the ratio of boys and girls in each class was made to conform as closely as possible to the ratio in the parallel class in School S: (3) the mean stanine score in each class was made as nearly equal as possible to the matching class in School S. These data are summarized in Table I. It must be emphasized that although students in School R were grouped artificially for the purposes of this study, these students were not grouped within the school itself during the academic year for instructional purposes.

TABLE I

COMPARISON OF GRADE X CLASSES IN SCHOOL S WITH MATCHING "ARTIFICIAL" CLASSES IN SCHOOL R

	School S				School R			
Class No.	N.	Boys	Girls	Mean Aggregate Stanine	N.	Boys	Girls	Mean Aggregate Stanine
1.	35	19	16	50.20	19	13	6	50.11
2.	33	17	16	46.06	26	11	15	45.65
3.	31	19	12	39.77	25	15	10	39.92
4.	28	.....	28	39.07	23	12	11	39.30
5.	30	21	9	35.70	25	18	7	35.44
6.	29	19	10	33.14	24	17	7	33.33
7.	18	9	9	31.56	17	9	8	31.06
8.	28	19	9	29.57	25	18	7	29.44
9.	16	9	7	25.38	13	7	6	26.08
Total	248	132	116	38.41	197	120	77	37.65

Each pair of matched classes was called a "group", thus creating nine groups. A "group" means, therefore, a specific pair of classes, while "class" refers only to a class in the specific school.

Two deviations from the criteria used for dividing the students from School R into "artificial" classes were found necessary in Classes 1 and 4. Class 1, the top-ranked class, was smaller than the number required to maintain the correct proportion. There were not enough high-achievement pupils entering School R to complete a class of twenty-eight pupils and still retain a sufficiently high mean standing of aggregate stanine score comparable to Class 1 from School S.

Class 4 from School S was composed entirely of girls. Because there were proportionately fewer girls in School R, the creation of an all-girl artificial class would have further distorted the ratio of boys and girls in the other classes. Therefore, eleven girls and twelve boys were assigned to this "artificial" class in spite of the parallel class being composed entirely of girls.

Basic Assumptions

The following assumptions were made in the study:

(1) Grouping pupils of homogeneous ability provides an opportunity for better teaching. It should be noted here, however, that it is not the purpose of this study to prove any superiority for homogeneous grouping. This assumption is based on the results established in the research literature. (See bibliography.)

(2) Teachers in both schools were comparable in ability and qualifications.

(3) It cannot be assumed that the curriculum in each course is the same in each school other than being within the limits of the Provincial Course of Studies. If the advantages of homogeneous grouping are to be achieved, and it was an assumption of this study that they were, the curriculum of each class consisting of homogeneously grouped pupils would differ. The low-ranked classes would receive only the core of each course while the top-ranked classes would receive an enriched curriculum.

Hypothesis

Mitchell feels that grouping "is a powerful device for easier teaching and for better learning" (14, p. 22), and that this should result in higher final grades. The hypothesis of the study was that homogeneously grouped students will get higher marks than students of comparable ability who are not so grouped. However, there is some doubt whether all pupils benefit equally. A sub-hypothesis of this study was that the lower-ranked pupils within homogeneous classes of high ability will receive lower final marks than they would if they had been placed in classes of heterogeneous ability. Similarly, teacher rating of top-ranked pupils in homogeneous classes of low ability would be higher than if the same pupils had been placed in classes of heterogeneous ability.

Analysis of Data

The testing of the hypothesis involved two major issues:

(1) Were the pupils in both schools comparable in initial ability as judged by their performance on the Grade IX Department of Education examinations?

(2) How did the final Grade X marks compare between schools, and between specific groups in the schools?

I. Comparison of the Initial Ability of Students in Both Schools

(a) *Total Group*

The hypothesis tested here assumed there was no significant difference between the initial ability of pupils entering the two schools.

This hypothesis was tested by comparing the performance of each group of pupils on each of the Grade IX Department of Education examinations.

The analysis of data confirming the above hypothesis is presented in Table II. No significant differences were found between the mean performances of each school's students on the eight Grade variables examined.

Significant differences in variability of marks between the two groups were found at the five percent level of confidence in Grade IX Language and Science. In either case, the actual difference in variability was less than a quarter of a stanine. This was not considered of significant magnitude to refute acceptance of the hypothesis. Therefore, it was concluded for purposes of this study, that there were no differences in the initial ability of students entering the two high schools.

(b) *Comparison of Paired Classes*

This analysis represented a further extension of the hypothesis stated above in section (a). The hypothesis tested here is that there were no significant differences in mean performance between pairs of matched classes for each of the eight grade IX variables used to evaluate the initial ability of the students.

Although the data are not presented, significant mean differences were found only in Group 8 which was a low ability group. Significant differences at the one percent level of confidence were found in Reading and Literature favoring School S's Group 8, and in Mathematics favoring School R's Group 8. No other significant differences were found.

Therefore, it was concluded, that for the purpose of the study, the hypothesis stated above was accepted. There were no significant differences in initial ability between each pair of classes of the nine groups. In Group 8, three (of a possible eight) significant differences were found. The contradictory direction of these differences indicated no reason to reject the hypothesis.

II. Comparability of Final Grade X Scores

(a) *Comparison of Total Performance in Each School*

Homogeneous grouping is reputed to afford the teacher a better opportunity to teach such classes because of the narrower range of ability in each class. Improved instruction should mean greater academic gains which, in turn, should be reflected in higher marks. Therefore, the hypothesis tested in this section is that students from a school where pupils are grouped in homogeneous classes (School

TABLE II

COMPARISON OF TOTAL GRADE IX ACHIEVEMENT OF PUPILS ENTERING THE GRADE X MATRICULATION PROGRAM AT SCHOOL S AND SCHOOL R IN THE FALL OF 1957

	School S			School R			Mean Difference	Analysis of Variance
Grade IX Variable	N.	Mean	S.D.	N.	Mean	S.D.	"t" test	"F" test
1. Reading (a)	248	6.6331	1.5908	197	6.3604	1.595	1.7905 N.S.D.	1.0058 N.S.D.
2. Social Studies (a)	248	6.4919	1.5579	197	6.3100	1.5709	1.2184 N.S.D.	1.0166 N.S.D.
3. Language (a)	248	6.2782	1.5629	197	6.0863	1.3396	1.3956 N.S.D.	1.3612 5% (S)(d)
4. Mathematics (a)	248	6.2782	1.6082	197	6.3096	1.5349	.1582 N.S.D.	1.0978 N.S.D.
5. Science (a)	248	6.3871	1.6590	197	6.4518	1.4084	.4444 N.S.D.	1.3880 5% (R)(d)
6. Literature (a)	248	6.3427	1.7155	197	6.1320	1.6838	1.2990 N.S.D.	1.0379 N.S.D.
7. S.C.A.T. (b)	248	68.532	20.020	197	67.013	20.855	.7762 N.S.D.	1.0855 N.S.D.
8. Stanine Aggregate (c)	248	38.41	7.8030	197	37.65	7.6175	1.1959 N.S.D.	1.0486 N.S.D.

(a) Results in these variable are reported in stanines.
(b) S.C.A.T. are reported as percentile rank.
(c) Stanine Aggregate is reported as the sum of variables 1 to 6.
(d) School with larger standard deviations.

S) should have higher marks reported for the total group than a school where there is no homogeneous grouping of students (School R).

The summary of the analysis of the data to test this hypothesis is presented in Table III.

TABLE III

COMPARISON OF TOTAL GRADE X ACHIEVEMENT OF MATRICULATION PUPILS IN SCHOOL S (N = 248) AND SCHOOL R (N = 197)

Grade X Variable	School S		School R		Significance of Differences	
	Mean	S.D.	Mean	S.D.	Means	Variance
Language 10	63.125	11.1490	62.280	10.3240	NSD	NSD
Social Studies 10	63.970	12.8675	61.420	12.3740	NSD	NSD
Mathematics 10	57.580	14.3540	58.425	15.6115	NSD	NSD
Science 10	66.370	11.5875	59.340	14.515	1%(S)	1%(R)
Literature 10	64.435	10.1610	63.400	12.265	NSD	1%(R)
Physical Education 10	60.705	6.750	68.425	8.960	1%(R)	1%(R)
H. & P.D. 10	64.645	9.070	62.760	10.1565	NSD	1%(R)
Electives	64.270	11.525	62.030	10.5250	NSD	NSD

Significant differences in mean final grades were reported for only two courses, Science 10 and Physical Education 10. In both courses, the differences were significant at the one percent level of confidence. One of these significant differences, Physical Education 10, favored School R where pupils were not grouped homogeneously. The other, Science 10, favored School S where pupils were grouped homogeneously.

It is concluded that with the exception of Science 10, the hypothesis is rejected. Students grouped homogeneously in one school do not receive significantly higher marks than do students from the school which does not group pupils on this basis.

In light of the above hypothesis, the significant difference of marks received in the two schools in Science 10 and Physical Education 10 leads in each case to two possible explanations. First, Science 10 is being taught more effectively to students who are grouped homogeneously and this is recognized when marks

are assigned, while Physical Education 10 is better taught to students who are not grouped according to academic ability. Second, the marking policy of the departments concerned in the two schools is basically different. Of the two possibilites, the difference between the Science 10 marks could best be explained on the basis of the influence of ability grouping. However, in Physical Education academic ability is known to bear little relationship to physical skills. Therefore, the most reasonable explanation would seem to be that the teachers of Physical Education 10 in School R rate their pupils on a different weighting of criteria than do the teachers at School S.

(b) *Comparison of Final Marks in Each Group*

This section is a further expansion of the hypothesis tested in the section above. The hypothesis remains essentially the same as before, namely, that students grouped homogeneously will get higher marks than comparable students who are not grouped according to ability.

Table IV presents the summary of the tests of significant differences between class means for each of the eight Grade X variables and for each of the nine pairs of matched classes. It seemed reasonable from the findings of this analysis to conclude that the hypothesis that pupils enrolled in homogeneous classes will receive higher marks could be rejected in all subjects except Science 10.

Because of their initial homogeneous placement, pupils in School S should show the benefits of improved instruction accruing from such class organization. This should be particularly evident for students of high and low ability although the trend could also be expected in the middle ability groups. This hypothesis was examined by dividing the nine pairs of classes into three main groups. These were considered as above-average, average and below- average groups.

Analysis of Table IV indicates that pairs of classes in groups 1, 2 and 3 (the above-average group) at School S performed at a significantly higher level in three instances, and were significantly lower in four others. In the average groups, consisting of classes 4, 5 and 6, there were three cases of significantly superior achievement and five cases of significantly lower achievement reported for the students from School S. Similar results were apparent between the paired classes of groups 7, 8 and 9 composing the below-average group. For this group there were four significant incidents of superior achievement by School S classes and seven of significantly lower achievement. Although generally inconclusive, these results further discount the hypothesis that superior marks will be received by homogeneously grouped pupils.

TABLE IV

SUMMARY OF THE SIGNIFICANT DIFFERENCES OF CLASS MEANS OF MARKS RECEIVED BY GRADE X PUPILS IN BOTH SCHOOLS

	High Initial Ability			Group Average Initial Ability			Low Initial Ability			Total
Class Grade X Variables	1	2	3	4	5	6	7	8	9	
Language 10	NSD	NSD	NSD	NSD	1%(R)	NSD	NSD	NSD	NSD	NSD
Social Studies 10	NSD	NSD	NSD	NSD	NSD	NSD	NSD	NSD	NSD	NSD
Mathematics 10	5%(R)	NSD	NSD	1%(R)	NSD	NSD	1%(R)	NSD	5%(R)	NSD
Science 10	NSD	5%(S)	1%(S)	NSD	1%(S)	1%(S)	1%(S)	1%(S)	5%(S)	1%(S)
Literature 10	NSD	NSD	NSD	NSD	NSD	NSD	NSD	NSD	NSD	NSD
Physical Ed. 10	1%(R)	5%(R)	1%(R)	5%(R)	1%(R)	1%(R)	1%(R)	1%(R)	1%(R)	1%(R)
H.P.D. 10	NSD	NSD	NSD	NSD	NSD	NSD	NSD	NSD	5%(R)	NSD
Electives	NSD	NSD	NSD	NSD	NSD	5%(S)	1%(S)	NSD	5%(R)	NSD

The above hypothesis was tested further by use of the Sign Test (11, p. 68). It was reasoned that if the hypothesis were true, mean marks from School S should be consistently higher for each of the nine classes, even though the differences between the paired classes of each group might not be statistically significant. A plus sign (+) was assigned to a class from School S which achieved a higher mean in any Grade X variable than the parallel class from School R. A minus sign (—) was given when the School R class had the higher mean. In a case where the means were equal the tie was distinguished with a zero (○). This analysis is presented in Table V.

The hypothesis that pupils grouped homogeneously in School S will receive higher marks than pupils of equal ability in School R is accepted only in Social Studies 10 at the five percent level and in Science 10 at the one percent level of confidence. On the contrary, the final marks assigned to students of Physical Education 10 and Health and Personal Development 10 at School R were consistently higher than those assigned at School S. The mean mark in Physical Education 10 was higher in School R at the one percent level of significance, while Personal Development grades were consistently higher at the five percent level of confidence.

(c) *Comparison of Variability of Marks in Each Group*

Another indication of the effectiveness of instruction is found in the range of marks earned. If the instruction is more effective, variability of marks within the class will increase. This is particularly evident in studies involving classes initially matched for ability and then taught by different methods of instruction. For this study then, a test of the improvement in instruction because of homogeneous grouping may be indicated by differences of variability between the paired classes.

The hypothesis to be tested in this section is that the marks of the students grouped homogeneously in School S will display greater variability than those students of like ability from School R where there is no attempt made to group pupils on this basis.

Repeating the same method of analysis used in the section above, i.e.: testing for differences in variance for significant differences and using the Sign Test, the following conclusions were reached. First, while class means in Social Studies 10 and Science 10 favored School S, variability of marks in these subjects was greater in the classes from School R. This means that pupils from School S received more homogeneous marks within each class than did the pupils from School R. This was evident in all classes including those from School S which had higher class means. Because class means and variability of marks were not consistently higher in

TABLE V
SIGN TEST COMPARISON OF MEANS OF MATCHED CLASSES

Grade X Variable	High Initial Ability			Average Initial Ability			Low Initial Ability			Favoring School S		Favoring School R	
	1	2	3	4	5	6	7	8	9	Ratio	P.	Ratio	P.
Language 10	+	−	+	−	−	−	+	−	+	4/9	.50	5/9	.746
Social Studies 10	+	+	+	+	+	+	+	+	−	8/9	.998*	1/9	.02
Mathematics 10	−	0	0	−	+	+	+	−	−	3/7	.500	4/7	.793
Science 10	+	+	+	+	+	+	+	+	+	9/9	1.000	0/9	.002
Literature 10	+	−	−	−	−	−	+	+	+	4/9	.500	5/9	.746
Physical Education 10	−	−	−	−	−	−	−	−	−	0/9	.002	9/9	1.000**
H. & P.D. 10	−	−	+	−	−	−	−	−	−	1/9	.02	8/9	.998*
Electives	−	+	−	+	−	+	+	−	−	4/9	.500	5/9	.746

*Significant at 5% level.
**Significant at 1% level.

favor of the homogeneously grouped pupils in School S, this suggests that the pupils did not receive superior instruction or that teachers did not recognize superior performance from some pupils with higher grades. Higher grades received by these pupils would have increased both the class means and variability of marks. Therefore, the above hypothesis is rejected because teachers tend to give more homogeneous marks to homogeneously grouped pupils in this study.

Further analysis of the greater variability of marks by pupils who had been grouped heterogeneously suggested the strong possibility that some pupils are allowed to perform at a lower level of achievement than could be expected from pupils of their ability. On the contrary, those pupils who had been grouped homogeneously appeared to achieve results more commensurate with class ability, therefore resulting in more homogeneous marks. This could be a strong endorsation for classifying pupils homogeneously, in order that more pupils may be motivated to achieve school grades which are commensurate with their ability.

Conclusions

This study assumed that homogeneous grouping of students is desirable inasmuch as this administrative arrangement of students will afford better instructional and learning opportunities in the classroom. Therefore, students in such schools should perform better than students of equivalent ability not so grouped. This study sought to test this hypothesis. With one, and possibly two exceptions this hypothesis was rejected.

Consider then, the dilemma of someone reading the transcript of two students from each of the two schools used in this study and for whom the same grades were reported. One student had all the institutional advantages of grouping procedures and competition and cooperation with his academic peers while the other had none of these. The reader not knowing that one set of marks was from a streamed program would find little to choose between each, all other things being equal. The findings of this study would suggest two possible explanations: first teachers do not recognize the possibilities of homogeneous grouping and are not demanding and/or recognizing the relatively superior performance of these students; or second, the evaluation policies of the homogeneously grouping school are such as to deny their students the recognition of the superior quality of instruction and the performance of the students.

The findings of this study would suggest that with the advent of streamed programs, grading practices, now more than ever, should receive the full attention of administrators and teachers. School

administrators whose pupils are grouped homogeneously, may find it necessary to devote increasing amounts of time towards helping teachers develop an awarness of the needs of classes of varying ability. Teachers will need assistance in assessing more accurately individual students and total class achievement. At the same time, a continuous analysis of grading procedures should be maintained within each class and within the entire school to ensure the assignment of valid grades. If some schools continue to group hetergeneously while others group homogeneously, further complications would become apparent. Assuming that instruction to classes of homogeneous ability is superior, and if the marks received by the pupils do not reflect this fact, then a double standard of marks will inevitably follow. This would be a partial solution to the problem of interpreting transcripts but it will also serve to add confusion by proliferating the number of standards used to assess student performance data. Some external assessment medium would then have to be employed to validly assess achievement on a comparable basis. This latter solution is not without its limitations, particularly if discretion is not used in the application of external assessments. This could well limit or even eliminate the advantages of present school accreditation practices. The solution to these problems is worthy of further experimental examination than was possible in this study.

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BOOK REVIEW

THE COIL OF LIFE. By Ruth Moore. New York — Alfred A. Knopf, 1961, pp xvi + 418, $6.50.

The title and jacket design of this book indicate that its subject is the biological significance of the nucleic acids. In actual fact, the greater portion of the book does not deal with nucleic acids directly, but is a history of the main developments in biology over the last two hundred years.

While the historical approach to present knowledge may be a wise one, the book suffers from an over-emphasis on earlier discoveries. It begins with 240 pages of detailed description of "Lavoisier's proving, through his discovery that breathing is a combustion, that the body is governed by physical laws; upon Wohler's showing that the secretions of the body were not mystical substances, but compounds makable by man; upon Bichat's finding of the tissues; upon Pasteur's proof that life is not created spontaneously; upon Fischer's demonstrating that proteins are chains of matter; upon Roux's and Driesch's opening glimpse into the miracle of development; . . . " and of many more of the early scientists and their work. The method of presentation of this historical material can only be described as laborious and unimaginative. The author *describes* to us the characteristics of the scientists and the conditions under which they work, but the men themselves do not emerge. Somehow one is left with the picture of dedicated and faceless men, rising, each in his own generation, to work his allotted time and pass on, nameless, helpless tools of Science. In a book which is written with the express purpose of explaining science to laymen, surely every effort should be made to create a manuscript which would be interesting to read.

The question may well be asked, "Who should write a book on science for laymen?" Should it be a journalist such as Ruth Moore who specializes in science writing, or should a scientist be diverted from his research to do it? While there may not be a generally applicable answer to this question, one of the main justifications for the journalist undertaking the task is surely that he can turn the skills of his trade to the creation of an account which is not only simple, but fascinating. That Ruth Moore has not succeeded in this admittedly arduous task seems to be due primarily to her lack of effective *selection* of material, and without selection sustained interest, let alone dramatic effect, is impossible. The crux of the matter may be that *first hand* acquaintance with a field may be necessary before an author can be selective, and at the same time accurate.

In *The Coil of Life* the wisps and threads of events tend to stray off in all directions, rather than being so fashioned as to contribute to the strength of the whole.

On the other hand, Miss Moore is to be complimented for her effective use of formulas and diagrams. She also includes a bibliography so that the reader who so desires may refer directly to many of the original papers dealing with the scientific discoveries she describes. There are a few errors, such as when she states that Baeyers "intuition" that plants form sugar from formaldehyde is correct; she seems to have failed to grasp the idea that what happens in the chemical laboratory may often be quite different from what happens in a living organism. However, on the whole the book has rather few inaccuracies in facts. She indicates in her preface that she took the care to submit parts of her book for criticism and comment to some of the scientists about whom she writes, and in addition, she has obviously done a good deal of reading herself in preparation for the writing of the book.

In all the 418 pages there is no relief from the eulogy to scientific achievement and the rigorous methods recognized by science. One might almost call it a tone of reverence that seems to pervade the book, and as continuous fare it becomes not only uninspiring, but rather annoying. Could the person have any sense of humor who would write (on page 223): "For seventeen year the Morgan fly squad bred fruit flies. There can have been few times and places in scientific laboratories with such an atmosphere of excitement and such a record of sustained enthusiasm . . . "

In summary, the book gives a clear description of recent advances in our knowledge of the role of nucleic acids in living organisms. Discussion of earlier discoveries in biology is prolonged and somewhat diffuse, with the result that continuity suffers. The presentation is such that it will be the unusual layman who will have the persistence to read the book through, but the one who does will find himself reasonably well informed in this field.

—Mary Spencer
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August, 1961

BOOK REVIEW

AFRICAN DEVELOPMENT AND EDUCATION IN SOUTHERN RHODESIA. By Franklin Parker. (Kappa Delta Pi: International Education Monographs, No. 2) Columbus, Ohio—Ohio State University Press, 1960, pp. xiv + 165, $1.75.

In a relatively short paperback book, Dr. Parker attempts to trace the history of non-white education in the most populous territory of the Rhodesia-Nyasaland Federation. Under a grant from Kappa Delta Pi, the Honor Society in Education, the author spent one academic year in Southern Rhodesia in the preparation of this volume.

Chapters One through Three—more than one-half of the book—are devoted to a résumé of general history, nearly all of which is a synthesis of standard secondary accounts. Emphasis is placed upon the arrival and hegemony of European settlers. Complex or crucial events are given unconvincingly simplified causes; the explanation for the grant of white self-government in 1923 is scarcely reconcilable with the political situation and the major issues that then existed. There seems to have been little attempt to balance the account with the rapidly-growing literature on African personalities, indigenous customs and changing tradition. The chapter dealing with official views of African developments is largely a discussion of the emergence of conflicting attitudes among the races and their sociological applications, which are not subjects easily integrated with the main theme of such a brief study. The work is fair, within the limitations imposed by the orientation and emphasis of its sources, but it lacks both the breadth and judgment that the study of Africa is beginning to require.

In the fourth chapter, which reviews the history of African education, the book comes to the heart of its subject. Mission and government policies are reported with competence, and the sources, though nearly all official, are more extensive. One regrets that the historically-significant and proto-nationalistic movement toward schools run by African-controlled Christian splinter sects is quickly and unsatisfactorily dismissed as "pseudo-religious" (p. 70). It is neither adequate nor accurate to imply that the "odd religious teaching" and the broader influence of these "independent, spurious schools" was regulated simply by government fiat. A few pages later (p. 89), in discussing the failure of the Jeanes system of minimally-trained rural teachers, the author discusses only the shortcomings of the Education and Native Affairs Ministries. However, in both the African church and the Jeanes school, the Africans' own unofficial attitudes were immediately and historically crucial. The first case marked the development of a concious, deliberate, im-

patient demand for more facilities and an assertion of the claim to autonomous or autochthonous advancement. Then, in reaction to the Jeanes movement, African opinion disdained and protested vehemently against the inferiorities and crudities as well as the subtler condescension which that system implied. Not until page 96, when a later period is considered, are any such African feelings mentioned, but then they are only those of the first African delegates to the official Advisory Board for Native Development.

The final chapter, dealing with education problems, is more replete with generalization than many would wish for such a specific and current issue. The introductory discussion (p. 107) of the Africans' historical and education psyche could have been more concrete, and the prognosis for multi-racial development in the new University College (pp. 110, 120) more analytical. References to the "Mau-Mau school usurpation in Kenya" (6.117) do not, because of an apparent misinterpretation of that issue, have at all the intended relevance to Rhodesian problems. The chapter, and the book, close on a truism that precludes a sense of critical stimulation.

A series of appendices present extracts from statistical records, summarize the administrative and academic structure of Southern Rhodesian education, and recount informally the events of a primary-school visitation by the author. The collected data are convenient and current. However, scholars will still have to return to the original journals and reports for the complete or documented details, and others will not find the analyses or syntheses of detail that they would wish.

Students of Rhodesian or African education will prefer to rely upon the relevant sections of more analytical, comprehensive and up-to-date works such as Richard Gray, *The Two Nations;* Thomas Franck, *Race and Nationalism;* Colin Leys (ed.), *A New Deal in Central Africa;* and Edward Clegg, *Race and Politics.* The sections of Lord Hailey's *African Survey* (revised) dealing with this topic remains most authoritative. Although these works treat larger subjects than the book under review they have the merits of providing more both of substance and of background. The general reader, who will require less of the statistical detail, will be likewise well-advised to prefer these studies which provide more critical and adequate treatment of the general historical context and the broader aspects of Federation policy within which Southern Rhodesia's current educational situation is developing.

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August, 1961